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S3	3888	dual with stack$2	US-PGPUB; USPAT; EPO; JPO; IBM_TDB	OR	ON	2006/05/03 16:32
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S11	4040	ipv6	US-PGPUB; USPAT; EPO; JPO; IBM_TDB	OR	ON	2006/05/03 16:33

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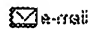**Welcome United States Patent and Trademark Office**

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☐ 1. **Performance enhancement of IP forwarding by reducing routing table co**
Pi-Chung Wang; Chia-Tai Chan; Yaw-Chung Chen;
Communications Letters, IEEE
Volume 5, Issue 5, May 2001 Page(s):230 - 232
Digital Object Identifier 10.1109/4234.922769

AbstractPlus | References | Full Text: PDF(60 KB)   **IEEE JNL**
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☐ 2. **A fast table update scheme for high-performance IP forwarding**
Pi-Chung Wang; Chia-Tai Chan; Yaw-Chung Chen;
Parallel and Distributed Systems, 2001. ICPADS 2001. Proceedings. Eighth In
Conference on
26-29 June 2001 Page(s):592 - 597
Digital Object Identifier 10.1109/ICPADS.2001.934871

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☐ 3. **The iflow address processor**
O'Connor, M.; Gomez, C.A.;
Micro, IEEE
Volume 21, Issue 2, March-April 2001 Page(s):16 - 23
Digital Object Identifier 10.1109/40.917999

AbstractPlus | References | Full Text: PDF(124 KB)   **IEEE JNL**
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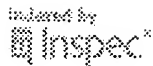
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1. <u>Small forwarding tables for fast routing lookups</u>

Mikael Degermark, Andrej Brodnik, Svante Carlsson, Stephen Pink

October 1997 **ACM SIGCOMM Computer Communication Review , Proceedings of the ACM SIGCOMM '97 conference on Applications, technologies, architectures, and protocols for computer communication SIGCOMM '97**, Volume 27 Issue 4

Publisher: ACM Press

Full text available: ▦ <u>pdf(1.62 MB)</u>   Additional Information: <u>full citation</u>, <u>abstract</u>, <u>references</u>, <u>citings</u>, <u>index terms</u>

For some time, the networking community has assumed that it is impossible to do IP routing lookups in software fast enough to support gigabit speeds. IP routing lookups must find the routing entry with the *longest matching prefix*, a task that has been thought to require hardware support at lookup frequencies of millions per second.We present a forwarding table data structure designed for quick routing lookups. Forwarding tables are small enough to fit in the cache of a conventional genera ...

2. <u>Fast address lookups using controlled prefix expansion</u>

V. Srinivasan, G. Varghese

February 1999 **ACM Transactions on Computer Systems (TOCS)**, Volume 17 Issue 1

Publisher: ACM Press

Full text available: ▦ <u>pdf(258.60 KB)</u>   Additional Information: <u>full citation</u>, <u>abstract</u>, <u>references</u>, <u>citings</u>, <u>index terms</u>, <u>review</u>

Internet (IP) address lookup is a major bottleneck in high-performance routers. IP address lookup is challenging because it requires a longest matching prefix lookup. It is compounded by increasing routing table sizes, increased traffic, higher-speed links, and the migration to 128-bit IPv6 addresses. We describe how IP lookups and updates can be made faster using a set of of transformation techniques. Our main technique, controlled prefix expansion, transf ...

Keywords: Internet address lookup, binary search on levels, controlled prefix expansion, expanded tries, longest-prefix match, multibit tries, router preformance

3. <u>Fast and scalable layer four switching</u>

V. Srinivasan, G. Varghese, S. Suri, M. Waldvogel

October 1998 **ACM SIGCOMM Computer Communication Review , Proceedings of the ACM SIGCOMM '98 conference on Applications, technologies, architectures, and protocols for computer communication SIGCOMM '98**, Volume 28 Issue 4

Publisher: ACM Press

Full text available: pdf(1.76 MB)   Additional Information: full citation, abstract, references, citings, index terms

In Layer Four switching, the route and resources allocated to a packet are determined by the destination address as well as other header fields of the packet such as source address, TCP and UDP port numbers. Layer Four switching unifies firewall processing, RSVP style resource reservation filters, QoS Routing, and normal unicast and multicast forwarding into a single framework. In this framework, the forwarding database of a router consists of a potentially large number of filters on key header ...

4 Memory-efficient state lookups with fast updates

Sandeep Sikka, George Varghese

August 2000 **ACM SIGCOMM Computer Communication Review , Proceedings of the conference on Applications, Technologies, Architectures, and Protocols for Computer Communication SIGCOMM '00**, Volume 30 Issue 4

Publisher: ACM Press

Full text available: pdf(384.82 KB)   Additional Information: full citation, abstract, references, citings, index terms

Routers must do a best matching prefix lookup for every packet; solutions for Gigabit speeds are well known. As Internet link speeds higher, we seek a scalable solution whose speed scales with memory speeds while allowing large prefix databases. In this paper we show that providing such a solution requires careful attention to memory allocation and pipelining. This is because fast lookups require on-chip or off-chip SRAM which is limited by either expense ...

5 Routing with a clue

Yehuda Afek, Anat Bremler-Barr, Sariel Har-Peled

December 2001 **IEEE/ACM Transactions on Networking (TON)**, Volume 9 Issue 6

Publisher: IEEE Press

Full text available: pdf(227.57 KB)   Additional Information: full citation, abstract, references, index terms

We suggest a new simple forwarding technique to speed up IP destination address lookup. The technique is a natural extension of IP, requires 5 bits in the IP header (IPv4, 7 in IPv6), and performs IP lookup nearly as fast as IP/Tag switching but with a smaller memory requirement and a much simpler protocol. The basic idea is that each router adds a "clue" to each packet, telling its downstream router where it ended the IP lookup. Since the forwarding tables of neighboring routers are similar, th ...

Keywords: Best matching prefix, IP forwarding, IP lookup, IP routing, MPLS

6 Routing with a clue

Anat Bremler-Barr, Yehuda Afek, Sariel Har-Peled

August 1999 **ACM SIGCOMM Computer Communication Review , Proceedings of the conference on Applications, technologies, architectures, and protocols for computer communication SIGCOMM '99**, Volume 29 Issue 4

Publisher: ACM Press

Full text available: pdf(1.26 MB)   Additional Information: full citation, abstract, references, citings, index terms

We suggest a new simple forwarding technique to speed-up IP destination address lookup. The technique is a natural extension of IP, requires 5 bits in the IP header (IPv4, 7 in IPv6) and performs IP lookup nearly as fast as IP/Tag-switching but with a smaller memory requirement and a much simpler protocol. The basic idea is that each router adds a "clue" to each packet, telling its downstream router where it ended the IP lookup. Since the forwarding tables of neighboring routers are similar, the ...

7 Mobile routing for large scale All-IP wireless network

Hongyi Li, Gerard Pieris

October 2000 **ACM SIGMOBILE Mobile Computing and Communications Review**, Volume 4 Issue 4
Publisher: ACM Press
Full text available: pdf(977.27 KB)   Additional Information: <u>full citation</u>, <u>index terms</u>

8 Scalable high-speed prefix matching

Marcel Waldvogel, George Varghese, Jon Turner, Bernhard Plattner
November 2001 **ACM Transactions on Computer Systems (TOCS)**, Volume 19 Issue 4
Publisher: ACM Press

Full text available: pdf(933.02 KB)   Additional Information: <u>full citation</u>, <u>abstract</u>, <u>references</u>, <u>citings</u>, <u>index terms</u>

Finding the longest matching prefix from a database of keywords is an old problem with a number of applications, ranging from dictionary searches to advanced memory management to computational geometry. But perhaps today's most frequent best matching prefix lookups occur in the Internet, when forwarding packets from router to router. Internet traffic volume and link speeds are rapidly increasing; at the same time, a growing user population is increasing the size of routing tables against which p ...

Keywords: collision resolution, forwarding lookups, high-speed networking

9 IP switching—ATM under IP

Peter Newman, Greg Minshall, Thomas L. Lyon
April 1998 **IEEE/ACM Transactions on Networking (TON)**, Volume 6 Issue 2
Publisher: IEEE Press
Full text available: pdf(154.32 KB)   Additional Information: <u>full citation</u>, <u>references</u>, <u>citings</u>, <u>index terms</u>

Keywords: Internet protocol, asynchronous transfer mode, broadband communication, communication system control, data communication, packet switching, protocols

10 A 50-Gb/s IP router

Craig Partridge, Philip P. Carvey, Ed Burgess, Isidro Castineyra, Tom Clarke, Lise Graham, Michael Hathaway, Phil Herman, Allen King, Steve Kohalmi, Tracy Ma, John Mcallen, Trevor Mendez, Walter C. Milliken, Ronald Pettyjohn, John Rokosz, Joshua Seeger, Michael Sollins, Steve Storch, Benjamin Tober, Gregory D. Troxel
June 1998 **IEEE/ACM Transactions on Networking (TON)**, Volume 6 Issue 3
Publisher: IEEE Press

Full text available: pdf(133.28 KB)   Additional Information: <u>full citation</u>, <u>references</u>, <u>citings</u>, <u>index terms</u>, <u>review</u>

Keywords: data communications, internetworking, packet switching, routing

11 A fast handoff scheme for wireless networks

Cheng Lin Tan, Kin Mun Lye, Stephen Pink
August 1999 **Proceedings of the 2nd ACM international workshop on Wireless mobile multimedia**
Publisher: ACM Press
Full text available: pdf(1.09 MB)   Additional Information: <u>full citation</u>, <u>references</u>, <u>citings</u>, <u>index terms</u>

12 Tree multicast strategies in mobile, multishop wireless networks

Mario Gerla, Ching-Chuan Chiang, Lixia Zhang
October 1999 **Mobile Networks and Applications**, Volume 4 Issue 3
Publisher: Kluwer Academic Publishers

Full text available: pdf(285.79 KB)   Additional Information: full citation, abstract, references, citings, index terms

Tree multicast is a well established concept in wired networks. Two versions, per-source tree multicast (e.g., DVMRP) and shared tree multicast (e.g., Core Based Tree), account for the majority of the wireline implementations. In this paper, we extend the tree multicast concept to wireless, mobile, multihop networks for applications ranging from ad hoc networking to disaster recovery and battlefield. The main challenge in wireless, mobile networks is the rapidly changing environment. We add ...

13 Universal continuous routing strategies
Christian Scheideler, Berthold Vöcking
June 1996 **Proceedings of the eighth annual ACM symposium on Parallel algorithms and architectures**
Publisher: ACM Press

Full text available: pdf(1.15 MB)   Additional Information: full citation, references, citings, index terms

14 Shortest paths and loop-free routing in dynamic networks
B. Awerbuch
August 1990 **ACM SIGCOMM Computer Communication Review , Proceedings of the ACM symposium on Communications architectures & protocols SIGCOMM '90**, Volume 20 Issue 4
Publisher: ACM Press

Full text available: pdf(1.08 MB)   Additional Information: full citation, abstract, references, citings, index terms

In this paper, we survey the existing methods for designing shortest paths routing algorithms for dynamic networks. We compare them based on worst-case communication and message complexity, and suggest new approach that yields a protocol with linear time and polynomial communication. The main idea behind our approach is to use a "dynamic synchronizer", which transforms a dynamic asynchronous network into static synchronous one. We believe this is an important methodol ...

15 IP lookups using multiway and multicolumn search
Butler Lampson, Venkatachary Srinivasan, George Varghese
June 1999 **IEEE/ACM Transactions on Networking (TON)**, Volume 7 Issue 3
Publisher: IEEE Press

Full text available: pdf(173.06 KB)   Additional Information: full citation, references, citings, index terms, review

16 The Click modular router
Robert Morris, Eddie Kohler, John Jannotti, M. Frans Kaashoek
December 1999 **ACM SIGOPS Operating Systems Review , Proceedings of the seventeenth ACM symposium on Operating systems principles SOSP '99**, Volume 33 Issue 5
Publisher: ACM Press

Full text available: pdf(1.46 MB)   Additional Information: full citation, abstract, references, citings, index terms

Click is a new software architecture for building flexible and configurable routers. A Click router is assembled from packet processing modules called *elements.* Individual elements implement simple router functions like packet classification, queueing, scheduling, and interfacing with network devices. Complete configurations are built by connecting elements into a graph; packets flow along the graph's edges. Several features make

individual elements more powerful and complex configuration ...

17 Packet classification on multiple fields

Pankaj Gupta, Nick McKeown

August 1999 **ACM SIGCOMM Computer Communication Review , Proceedings of the conference on Applications, technologies, architectures, and protocols for computer communication SIGCOMM '99**, Volume 29 Issue 4

Publisher: ACM Press

Full text available: pdf(1.46 MB)   Additional Information: full citation, abstract, references, citings, index terms

Routers classify packets to determine which flow they belong to, and to decide what service they should receive. Classification may, in general, be based on an arbitrary number of fields in the packet header. Performing classification quickly on an arbitrary number of fields is known to be difficult, and has poor worst-case performance. In this paper, we consider a number of classifiers taken from real networks. We find that the classifiers contain considerable structure and redundancy that can ...

18 Optimizing TCP forwarder performance

Oliver Spatscheck, Jørgen S. Hansen, John H. Hartman, Larry L. Peterson

April 2000 **IEEE/ACM Transactions on Networking (TON)**, Volume 8 Issue 2

Publisher: IEEE Press

Full text available: pdf(119.23 KB)   Additional Information: full citation, references, citings, index terms

Keywords: TCP, firewall, proxy, router

19 Faster IP lookups using controlled prefix expansion

V. Srinivasan, George Varghese

June 1998 **ACM SIGMETRICS Performance Evaluation Review , Proceedings of the 1998 ACM SIGMETRICS joint international conference on Measurement and modeling of computer systems SIGMETRICS '98/PERFORMANCE '98**, Volume 26 Issue 1

Publisher: ACM Press

Full text available: pdf(1.31 MB)   Additional Information: full citation, abstract, references, citings, index terms

Internet (IP) address lookup is a major bottleneck in high performance routers. IP address lookup is challenging because it requires a *longest matching prefix* lookup. It is compounded by increasing routing table sizes, increased traffic, higher speed links, and the migration to 128 bit IPv6 addresses. We describe how IP lookups can be made faster using a new technique called *controlled prefix expansion*. Controlled prefix expansion, together with optimization techniques based on dyn ...

20 IP micro-mobility protocols

Andrew T. Campbell, Javier Gomez-Castellanos

October 2000 **ACM SIGMOBILE Mobile Computing and Communications Review**, Volume 4 Issue 4

Publisher: ACM Press

Full text available: pdf(1.12 MB)   Additional Information: full citation, abstract, citings, index terms

The IETF Mobile IP Working Group is discussing a number of enhancements to the base protocol to reduce the latency, packet loss and signaling overhead experienced during handoff. In this article, we discuss a number of "micro-mobility protocols" that extend Mobile IP with fast handoff and paging capabilities. The aim of this article is not to provide an exhaustive survey of these protocols. Rather, we discuss the motivation behind micro-mobility, present common characteristics that a number of p ...